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Stability analysis in chilli (*Capsicum annuum* L.) under open and mahogany (*Swietenia mahagoni* L.) based agroforestry system

L S Datta & A N Dey

Faculty of Horticulture
Uttar Banga Krishi Viswavidyalaya
Pundibari, Cooch Behar-736 165, West Bengal, India.
E mail: suchanddatta@rediffmail.com

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Abstract

Eight chilli genotypes (*Capsicum annuum*) were evaluated for yield and yield parameters under open and mahogany (*Swietenia mahagoni*) based agroforestry system for stability analysis at northern West Bengal. Genotype and environment interactions for plant height, primary and secondary branches, plant spread, stem girth, fruit length and diameter and yield were significant indicating differential response of genotypes under different environments. Significant linear and nonlinear components of genotype - environments were recorded for plant height, fruit length and yield. The chilli genotype CA-5 may be adopted for cultivation under favourable (open) conditions in view of its stabilty. Though CA-12 and Bhaghyalakshmi recorded lower yield than the mean yield, these two genotypes were stable. Bhaghyalakshmi was stable under open and agroforestry condition and CA-12 was specifically adapted under agroforestry condition.

Keywords: agroforestry, chilli, *Capsicum annuum*, mahogany, *Swietenia mahagoni*, stability analysis.

Introduction

Mahogany (*Swietenia mahagoni* L.) is a large, fast growing timber species in northern West Bengal which does not fully utilize solar energy and land resources at early stages of the life cycle. Chilli (*Capsicum annuum* L.) can be grown successfully in mahogany based horti-silviculture system in northern West Bengal. However, information regarding the stability of chilli genotypes under different growing systems is lacking. Hence, the present experiment was undertaken to study the stability of chilli genotypes under open and mahogany based agroforesrty system.

Materials and methods

Eight genotypes of chilli (CA-5, CA-9, CA-11, CA-12, CA-13, CA-14, CA-17 and Bhagyalakshmi) were evaluated for their stability under open and mahogany-based agroforestry system during *rabi* season of 2005-06 and 2006-07. The field experiment was laid out in a factorial randomized block design with three replications at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar

(West Bengal). The experimental soil was sandy loam in texture and coarse in nature with poor water holding capacity and the climate was humid tropical. Under both the growing systems, five week old chilli seedlings were transplanted during third week of November in a plot size of 3.00 m × 2.25 m with a spacing of 45 cm × 30 cm. The age of mahogany plantation was four years and spacing was 5.0 m × 3.5 m. Light intensity was recorded by digital Lux meter (Model TES-1332). Light intensity was recorded from the 4th week to 24th week after transplanting. Tree canopy reflected some light which could be indicated by estimating albedo, which is the ratio of reflected and received radiation. The crop was managed by recommended package of practices (Anon 2003). Observations on plant height, primary and secondary branches, stem girth, plant spread, fruit length and diameter were recorded from 10 randomly selected plants from each replication. Yield was calculated on the basis of plot yield. Stability analysis was done by using Genres statistical package as per method suggested by Eberhat & Russel (1966).

Results and discussion

The average light intensity varied from 214.67 × 100 lux to 770.13 × 100 lux in agroforestry system whereas it varied from 398.90 × 100 lux to 942.93 × 100 lux in the open field. The agroforestry system showed albedo ranging from 0.22 to 1.38, on an average it was 0.64, which is in conformity with the findings of Singh (1986) and Jha & Gupta (2003).

Pooled analysis of variance showed that mean differences between chilli genotypes were highly significant in all the characters under study (Table 1). Genotype and environment interactions for plant height, primary and secondary branches, plant spread, stem girth, fruit length and diameter and yield were significant indicating differential response of genotypes under different environment. The component of G x E interaction was also significant for all characters indicating differential response of genotypes that were grown under different environment

Table 1. Genotype x environment and regression analysis for growth and fruit characters and yield of chilli

Source	DF	Plant height (cm)	No. of primary branches	No. of secondary branches	Plant spread (cm)	Stem girth (cm)	Fruit length (cm)	Fruit diameter (cm)	Yield (t ha^{-1})
Genotype	7	222.10**	0.45**	15.74**	44.82**	0.03**	1.48**	0.02**	12.23**
Environment	3	370.68**	1.27**	8.17**	53.16**	0.02**	0.20**	0.07**	15.32**
G x E interaction	21	28.12**	0.13**	2.04**	9.47**	0.005**	0.10**	0.004**	2.57
Environment + (G x E)	24	70.94**	0.27**	2.81	14.93*	0.01**	0.11	0.01	3.89*
Environment (linear)	1	1111.97**	3.82**	24.53**	159.50**	0.01**	0.60**	0.06**	45.97
(G x E) linear	7	34.47**	0.23*	2.31	13.90	0.004	0.21**	0.004	2.86**
Pooled deviation	16	21.83**	0.06**	1.69**	6.34**	0.00**	0.04**	0.003**	1.71**
Pooled error	64	3.61	0.06	0.79	1.45	0.003	0.03	0.001	0.04

* = Significant at 5% level, ** = Significant at 1% level

conditions where relative merits of different genotypes changed in environment (Wani *et al*. 2003). Partitioning of mean squares due to genotype x environment interaction into linear and non-linear compounds revealed that major portion of interactions in all the parameters was attributable to linear component. Significant linear and non-linear components of genotype-environments were recorded for plant height, fruit length and yield. This indicated that the prediction of performance in different environments was possible for all the growth, yield and quality characters.

Stability parameters for different growth and yield characters of chilli are presented in Tables 2 & 3. Out of eight genotypes, five showed significant S^2di value which indicated that these genotypes were unstable with respect to plant height. Genotypes CA-5 and CA-11 with shorter plant height than the mean value (as shorter plant height is desirable), bi value about one and very low and non significant S^2di indicated that these genotypes were stable for plant height with respect to growing condition. Senapati & Sarkar (2002) observed that genotype x environment interactions were significant for plant height. In this experiment genotype x environment interaction was also significant. Primary and secondary branches plant^{-1} varied from 5.08 to 6.18 and 15.07 to 20.15 with an average of 5.71 and 16.93, respectively. With respect to primary branches, CA-5 and CA-9 were specifically adapted under open condition as bi > 1 and had low and non-significant S^2di value and CA-17, CA-12 were specifically adapted under agroforestry condition as bi < 1 and had low and non significant S^2di value. In case of secondary branches, CA-5, CA-9 and Bhagyalakshmi were specifically adapted under open condition as their bi > 1, and had higher individual mean value than the population mean and low and non-significant S^2di value. In case of plant spread, all genotypes except CA-12 and Bhagyalakshmi, showed significant S^2di value which indicated their instability. The instability might be due to variation in the existing environment of the growing system.

Table 2. Stability parameters for plant height, primary and secondary branches and plant spread in chilli

Genotype	Plant height (cm)			No. of primary branches			No. of secondary branches			Plant spread (cm)		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d
CA-5	90.83	1.01	-2.75	5.80	1.60	-0.03	20.15	2.63	0.33	54.88	1.87	13.48**
CA-9	97.85	0.91	21.17**	5.75	1.93	-0.01	19.27	1.40	0.20	54.13	-0.56	8.03**
CA-11	85.79	0.97	0.45	5.49	0.92	-0.02	17.25	1.32	2.84**	52.90	1.20	4.63*
CA-12	101.69	0.70	24.71**	5.93	0.03	0.01	15.55	0.90	1.44	54.54	0.91	0.69
CA-13	86.19	1.94	35.37**	5.08	0.81	0.002	15.17	0.28	2.28**	46.58	0.38	4.45**
CA-14	107.43	0.50	-0.20	5.55	0.21	-0.04	15.07	1.15	0.07	56.68	0.87	-0.68
CA-17	95.23	0.492.	36.34**	6.18	0.79	-0.02	15.33	-0.27	0.42	54.59	1.25	7.98**
Bhagyalakshmi	93.78	1.49	30.68**	5.90	1.71	0.13**	17.68	0.59	-0.52**	49.78	2.09	0.28
Mean	94.85			5.71			16.93			49.48		
SE	2.70			0.14			0.75			1.46		

* = Significant at 5% level, ** = Significant at 1% level

Table 3. Stability parameters for stem girth, fruit length, fruit diameter and yield of chilli

Genotype	Stem girth (cm)			Fruit length (cm)			Fruit diameter (cm)			Fruit yield (tha^{-1})		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
CA-5	1.58	0.03	0.01**	6.06	2.32	-0.01	1.16	0.81	0.001	10.23	2.04	2.10
CA-9	1.53	0.51	0.002**	5.40	-1.16	-0.01	1.12	1.75	0.002	8.88	1.27	1.61**
CA-11	1.37	1.08	0.01**	5.06	0.70	0.1	1.10	2.31	0.00	9.87	1.93	5.13**
CA-12	1.47	1.66	0.01**	5.28	-0.30	0.02	0.80	1.06	0.00	7.03	0.74	1.25
CA-13	1.30	2.01	0.004**	6.58	2.96	0.08*	1.04	0.49	0.002	6.00	0.08	0.15**
CA-14	1.37	1.22	0.004**	6.06	3.30	-0.02	0.94	0.74	0.10	6.34	0.57	-0.03
CA-17	1.44	1.45	0.003**	6.24	-0.60	-0.02	1.04	0.64	0.004	6.19	0.40	0.23**
Bhagyalakshmi	1.45	0.04	0.001*	6.69	0.79	0.02	0.82	0.22	0.00	6.49	0.98	2.94
Mean	1.44			5.92			1.00			7.63		
SE	0.05			0.11			0.03			0.26		

* = Significant at 5% level, ** = Significant at 1% level

None of the genotypes showed stability with respect to plant spread which indicated that under different environments genotypes produced different canopy, which was significant from environment to environment. Among the eight genotypes, only one, namely, CA-13 had significant S^2di value, which indicated that the genotype was unstable under different growing environments with respect to fruit length. With respect to fruit diameter all the genotypes showed non-significant S^2di value which indicated that fruit diameter did not vary with the growing system. In case of fruit yield, out of the eight genotypes, four showed significant S^2di value, which indicated that these genotypes were unstable with respect to growing system. The genotype, CA-5 was specifically adapted to open condition as bi >1 and low and non-significant S^2di value. Though, CA-12 and Bhagyalakshmi produced lower yield than the mean yield these two genotypes were stable. The genotype, Bhagyalakshmi was stable under open and agroforestry condition and CA-12 was specifically adapted under agroforestry condition.

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